U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF SOILS—MILTON WHITNEY, Chief.

IN COOPERATION WITH THE BUREAU OF PLANT INDUSTRY, WM. A. TAYLOR, CHIEF; SOIL FERTILITY INVESTIGATIONS, OSWALD SCHREINER, IN CHARGE.

SOIL SURVEY OF THE AROOSTOOK AREA, MAINE.

BY

LEWIS A. HURST, OF THE BUREAU OF PLANT INDUSTRY, IN CHARGE, AND E. W. KNOBEL AND B. H. HENDRICKSON, OF THE BUREAU OF SOILS.

W. E. McLENDON, INSPECTOR, NORTHERN DIVISION.

[Advance Sheets—Field Operations of the Bureau of Soils, 1917.]

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., April 24, 1920.

SIR: I have the honor to transmit herewith the manuscript report and maps covering the survey of the Aroostook Area, Maine, and to recommend that they be published as advance sheets of Field Operations of the Bureau of Soils, 1917, as authorized by law. This work was done in cooperation with the Bureau of Plant Industry.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

Hon. E. T. MEREDITH,
Secretary of Agriculture.

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SOIL SURVEY OF THE AROOSTOOK AREA, MAINE.

By LEWIS A. HURST, of the Bureau of Plant Industry, In Charge, and E. W. KNOBEL and B. H. HENDRICKSON, of the Bureau of Soils.—Area Inspected by W. E. McLENDON.

DESCRIPTION OF THE AREA.

Aroostook County, within which the area covered by the present survey lies, forms the extreme northern part of Maine, and is bounded on all sides except the south by the Dominion of Canada. It embraces a large proportion of the so-called "Big Woods" of Maine. The present survey includes, without re-survey, that part of the county covered by the soil survey of 1908, called the Caribou area, and in addition practically all the potato-growing districts of the county except some settlements along branch lines of the Bangor & Aroostook Railroad in the vicinity of Frenchville and Fort Kent, elsewhere along the St. John River, and at Eagle Lake, Ashland, Oakfield, Patten, and a few other places to the south. It embraces all of the first, most of the second, and parts of the third and fourth tiers of towns,[1] extending along the New Brunswick, Canada, line from the St. John River on the north to the southern boundaries of Linneus and Hodgdon Towns on the south. Its width from east to west varies from 24 miles at Presque Isle and Caribou to 6 miles at Monticello and Littleton, and less at the north where it tapers to a point. Its maximum length from north to south is about 90 miles. The area covered by the survey is 1,090 square miles, or 697,600 acres.

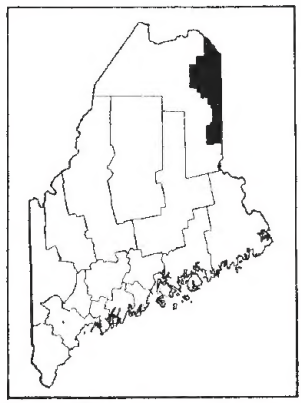

FIG. 1.—Sketch map showing location of the Aroostook area, Maine.

The Aroostook area includes the full towns of Van Buren, New Sweden, Woodland, Caribou, Limestone, Washburn, Fort Fairfield, Mapleton, Presque Isle, Easton, Mars Hill, Blaine, Bridgewater, Monticello, Littleton, Houlton, Ludlow, New Limerick, Linneus, and Hodgdon, and Cyr, Hamlin, Connor, and Caswell Plantations. It also includes parts of Stockholm, Perham, Chapman, and Westfield Town, as well as parts of Westmanland, Wade, Castle Hill, and Hammond Plantations, and small parts of numbered towns, as D. R. 2, X. R. 3, etc. The irregular shape of the area is due to the fact that the settlements have penetrated farther into the "Big Woods" at some points than at others. The thickly forested condition and lack of roads and other facilities make it impracticable to survey the entire county in detail, and even a reconnoissance of the wooded

[1] The term "town" is synonymous with "township."

areas is deemed impracticable at present. The unsurveyed part of the county consists almost entirely of dense forest, held in large tracts by estates or lumbering companies who have found it more profitable to retain ownership and harvest the forest products as they mature than to dispose of their holdings for the purpose of settlement. Large quantities of pulp wood are annually shipped out of the county to paper mills in Penobscot County.

The area surveyed consists of a succession of long, broad, high ridges and swells, with level to undulating tops and slopes, forming drainage divides which in general have a gradual descent to the streams. Depressions or sinks, including numerous valleys and flats, occur at intervals throughout the upland. Most of the sinks are occupied by the smaller lakes, ponds, or swamps. The larger lakes, on the contrary, more often owe their origin to obstructions built across preglacial valleys by glacial action. Nickerson, or Half Moon, Lake, near Houlton, is an excellent example of such formation. The larger Muck and Peat swamps represent former lakes and ponds that have gradually been filled in through the accumulation of vegetable matter, mingled with some mineral soil washed in from the surrounding uplands. These Muck and Peat deposits are generally shallow, but the bottoms of some of them have not been reached. The more sluggish streams often meander through valleys filled with Muck and Peat.

The average elevation above sea level is between 500 and 600 feet, but there are a number of high hills or low mountains rising above the general level. The hillier or rougher portion of the area lies west and southwest of Presque Isle and includes Hobart Hill, Quaggy Joe and Green Mountains, McDonald Mountain, Pyles Mountain, and Haystack Mountain. The most conspicuous of these is Haystack Mountain, which is visible for long distances, as is also Mars Hill, near the village of that name. The latter peak rises to a height of 1,695 feet above tide level.

The Aroostook area lies wholly within the St. John basin. Three main river systems carry the drainage—the St. John River on the north, the Aroostook River in the central part, and the two branches of the Meduxnekeag River to the south. All the rivers are fed by a comprehensive network of tributaries, and the area for the most part is naturally well drained.

Many lakes and ponds occur throughout the area. Some of these are small and shallow and are gradually filling up with soil wash and the remains of vegetation, but there are a few lakes of considerable size and depth, including Drew Lake, Nickerson Lake, Caribou Lake, and Echo Lake. The largest lakes of the county, however, lie just outside the area surveyed. The numerous bodies of water furnish recreation grounds for a large number of tourists who visit this section annually to fish and hunt.

This region was early settled along the St. John River, but development of the interior did not begin until the settlement at Fort Fairfield, in 1816, by immigrants from New Brunswick. Somewhat later the settlement of Presque Isle was begun. About 1836 to 1837, with opening of the Military Road to Presque Isle, settlers from the southern part of the State were attracted to this region and settled in the vicinity of Presque Isle and Caribou, and in 1839, when the county was organized, it had a population of approximately 9,000, largely made up of French, but with a few English traders. The county was enlarged to its present dimensions in 1843. A colony of Swedes was established about 1870 in New Sweden Town. With no markets available, these settlers had a hard struggle, but some of the best farms in the area are now to be found in this section. By 1890 the population of the county had increased to 49,589, and by 1900 to 60,744. The census of 1910 showed a total population for the county of 74,664, the greater part of which is centered within the limits of the present survey. The character of the population varies somewhat with the locality. Canadian French occupy almost exclusively the northern part of the area in the vicinity of the St. John River. Farther south are the Swedish settlements. The remainder of the area is much more cosmopolitan, but for the most part made up of descendants of immigrants from various States.

The general appearance of the farms and farm buildings, as well as the dwellings in the towns, indicates conditions of thrift and prosperity. Water power has always been used for running sawmills and grist mills, but in recent years the falls of the Aroostook River below Fort Fairfield have been exploited, and practically every town and village in the area is now furnished with electricity for light and power purposes. Many of the farmers have taken advantage of the opportunity to modernize their homes. The falls and rapids of the St. John River, at Great Falls, just over the international border, offer further opportunities for electrical development.

Houlton, the county seat, is the largest town in the area, though Presque Isle, Fort Fairfield, and Caribou are close rivals. Plate I, figures 1 and 2, give distant views of these towns and show the character of the surrounding country. Van Buren, on the St. John River, is an important local marketing center. There are numerous other towns and villages, including Littleton, Monticello, Bridgewater Center, Robinsons, Mars Hill, Blaine, Westfield, Mapleton, Washburn, Limestone, New Sweden, and Stockholm.

The Bangor & Aroostook Railroad, with its branch lines, furnishes transportation facilities for most of the area. Branch lines of the Canadian Pacific Railroad extend to Houlton and Presque Isle and

[1] Since this report was written the preliminary announcement of the population of Aroostook County and its civil divisions in 1920 has been issued by the Bureau of the Census, as follows: Aroostook County, 81,728; urban, 3,451; rural, 78,276; Fort Fairfield, 1,993; Presque Isle, 3,452.

carry large quantities of farm products. An electric road from Presque Isle to Caribou and New Sweden aids in marketing local products.

Buyers or jobbers from all sections of the country come to the Aroostook section each year, or are represented by local buyers, to purchase the large potato crop. The early varieties, including the Bliss and Cobbler, go principally to Florida, Georgia, South Carolina, North Carolina, Virginia, Maryland, Delaware, and New Jersey, as seed stock for the early spring markets of the following year. The later varieties, including the Green Mountain, Norcross, Carman, Snow, Spaulding No. 4, Giant, and Sir Walter Raleigh, are shipped out more generally for table use, although they too are used for seed in some sections, particularly Long Island and New Jersey. No organization exists among the growers for marketing the crop direct, and very little marketing outside the area is done by the farmers themselves. The price fluctuates from year to year, but prior to the present war period the average price paid the growers was about $1.25 a barrel, the ordinary range being from $1 to $1.50. In 1914, however, potatoes sold as low as 10 cents a barrel to the starch factories, when an overproduction and lack of markets existed. During 1916 and 1917 prices advanced to $3 to $5, and many of the farmers were able to sell part of their crops for as much as $7 and $8 a barrel. Hay, the other important cash crop, commands a good price in Boston, the principal market.

CLIMATE.

Owing to its northern position on the eastern seaboard, the Aroostook area naturally has a severe winter season. The cold of the winters, however, is less noticeable than in those sections of the State farther south immediately on the coast, where the humidity is considerably greater. The summers are particularly mild and pleasant, with not more than a week or two of hot weather. Almost every winter there are days when the thermometer registers very low, and occasionally it may go to 30° or more below zero.

Snow may fall in the latter part of September, but it seldom comes before the first or second week in October. When it falls so early the snow seldom lasts more than a few days, and it frequently disappears after the first day. The snows which fall later in the month, or in November, usually remain throughout the winter. The ground usually does not freeze very deep on account of the heavy covering of snow. This protects the grain crops, except in exposed situations, as on the hilltops, where the snow may be blown off by heavy winds. Here grains usually fail to make a stand the following season. When the snow melts in the spring the frost soon leaves the ground, and the soil quickly dries out and is ready for cultivation.

The annual precipitation of 30 to 35 inches is fairly uniform in distribution, though a short period of dry weather may occur in July and August. This is seldom severe enough to injure crops, as the soils are well adapted to withstand drought.

Though frosts may occur every month in the year, it is practically safe to exclude July. Light frosts often occur in mid-June or late in August. The average length of the growing season ranges from about 94 days at Houlton to 103 days at Van Buren. The average date of the last killing frost in the spring at Houlton, according to records of the Weather Bureau station covering a period of four years, is June 6, and that of the first in the fall, September 17. The latest killing frost in the spring recorded here occurred June 28, and the earliest recorded in the fall, on September 6. The average dates of last and first killing frost at Van Buren, covering a period of four years, are June 4 and September 6, and the dates of extreme latest and earliest frost, June 28 and August 26, respectively.

The following table gives the normal monthly, seasonal, and annual temperature and precipitation as recorded by the Weather Bureau stations at Houlton and Van Buren, the former in the southern, and the latter in the northern, part of the area:

Normal monthly, seasonal, and annual temperature and precipitation at Houlton.

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year (1914).	Total amount for the wettest year (1912).
	°F.	°F.	°F.	*Inches.*	*Inches.*	*Inches.*
December	23.5	48	−30	2.37	0.80	2.30
January	14.8	52	−33	2.44	1.95	1.60
February	14.0	45	−29	2.12	.90	2.10
Winter	17.4	52	−33	6.93	3.65	6.00
March	25.7	74	−18	2.38	1.20	3.21
April	39.6	84	− 2	2.00	1.27	1.95
May	51.4	90	26	2.18	1.20	3.20
Spring	38.9	90	−18	6.56	3.67	8.36
June	59.3	90	28	3.29	4.05	3.20
July	67.4	95	32	2.54	1.31	3.45
August	64.8	94	35	2.81	1.01	8.40
Summer	63.8	95	28	8.64	6.37	15.05
September	57.3	95	25	2.80	1.35	1.50
October	50.2	79	15	2.84	2.21	4.36
November	34.9	68	3	2.18	1.50	.95
Fall	47.5	95	3	7.82	5.06	6.81
Year	41.9	95	−33	29.95	18.75	36.22

Normal monthly, seasonal, and annual temperature and precipitation at Van Buren.

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.
December	18.0	48	−42	2.68	2.60	4.70
January	9.9	47	−36	2.30	1.42	2.80
February	9.1	43	−35	2.40	1.61	1.80
Winter	12.3	48	−42	7.38	5.63	9.30
March	22.9	63	−23	2.62	.78	3.20
April	37.5	77	0	1.90	1.08	2.30
May	48.8	85	22	3.14	3.26	.90
Spring	36.4	85	−23	7.66	5.12	6.40
June	57.0	94	26	3.96	3.27	6.20
July	64.6	95	39	3.55	2.54	5.90
August	63.0	92	30	3.42	.15	4.40
Summer	61.5	95	26	10.93	5.96	16.50
September	55.3	89	25	3.20	2.20	3.70
October	45.5	79	12	3.49	1.14	2.87
November	30.2	65	− 6	4.93	1.60	3.00
Fall	43.7	89	− 6	11.62	4.94	9.57
Year	38.5	95	−42	34.51	21.65	41.77

AGRICULTURE.

The early settlers who drifted into this region from New Brunswick, Canada, found it covered with a dense forest of evergreen and deciduous trees, and this still occupies the greater proportion of the county, particularly the western part. The evergreens, including arbor vitæ, cedar, fir, spruce, tamarack, and white pine, are found for the most part on the more poorly drained soils, while the deciduous growth, including mainly yellow birch, maple, and beech, with which is mixed some white pine, spruce, and fir, is largely confined to the knolls and ridges, where drainage is well established. White birch, elm, ash, and poplar are generally encountered in the "burnt-over" areas and in the mixed lands. It was from the marketing of the abundant white pine—the only timber considered worth marketing—that the early settlers obtained an income. Owing to the lack of better facilities, most of this pine timber was "squared" in the woods, "skidded" to the nearest stream, and later floated out with the spring freshets. The timber thus harvested was more or less wasted, as rated by present standards of marketing forest products. These squared timbers were used mostly for shipbuilding. In recent

years all of the various forest products have come into use. The yellow birch is used for veneering as well as for lumber. The maple at one place is being turned into shoe lasts and other specialties, while the spruce, fir, poplar, and other woods are being rapidly "peeled" for manufacture into pulp at Millinocket. Sawmills and various woodworking industries are located in all the towns and villages in the area. The largest mill, near Van Buren, on the St. John River, receives logs from cuttings more than 200 miles above.

Though settlements were made much earlier, it was not until about 1830, with the building of the military road from Bangor to Houlton and its extension to Presque Isle and Caribou, that agricultural development began. This road furnished an outlet to the markets in the southern part of the State. The small tracts which had been cleared up to that time were devoted almost exclusively to the production of oats, rye, wheat, potatoes, and hay for domestic use. Any surplus hay and grain was fed to live stock, which could be driven to market. For many years almost the only markets available were the near-by lumber camps, which were operated during the winter months. The grains were ground into flour and feed at local water mills.

A steady but comparatively slow development continued for the next 30 or 40 years, but without railroads there was little incentive for greater extension of agriculture in the production of bulky crops like hay and potatoes. The first railroad, a branch of the Canadian Pacific, which was then building its main line up the St. John Valley, was built to Houlton in 1862, and in 1875 another was constructed to Fort Fairfield. The latter was extended to Caribou in 1876, and to Presque Isle in 1881. These indirect lines of shipment were the only ones serving the transportation needs of the county for about 20 years, or until 1893 94, when the Bangor & Aroostook Railroad was built from Bangor to Caribou and Fort Fairfield. Following the building of these latter roads development became quite rapid.

Up to the time of the building of the railroads into Aroostook County the agricultural practices had changed little from those of the early settlers. With the construction of the first starch factory in the area, in 1874, the farmers turned from oats, rye, wheat, buckwheat, and hay, as the chief crops, to potatoes. Other factories were built at various places where farmers would contract to grow enough potatoes to justify the investment. With the increase in acreage there was frequent overproduction, and to offset this, markets were sought outside the area. As markets were extended the acreage in potatoes steadily increased. The census of 1880 shows 14,009 acres in potatoes, with a production of 2,245,594 bushels, or 801,767 barrels, an average yield per acre of about 160 bushels, or 57 barrels, per acre. In 1889 there were 16,640 acres in potatoes, which pro-

duced 2,746,765 bushels. The greatest increase in potato production, however, came after this time. The census of 1900 showed 41,953 acres planted, with an average yield of 56 barrels per acre. The census of 1910 shows a still greater increase in production, 17,514,491 bushels being gathered from a total of 75,738 acres in 1909. This is equal to 6,368,906 barrels,[2] with an average of 84 barrels per acre. The increase in production from 1890 to 1910 has been due not only to the development of the starch industry, but more particularly to the building of the Bangor & Aroostook Railroad, which made available an outside market for both seed and table stock. This has led up to the present important phase of the potato industry, the supplying of seed for the use of potato growers in more southern States. It is generally agreed among the latter that northern-grown seed is superior to the home-grown product, and the "Aroostook" seed potato, as well as that for table use, is known all over the country, particularly in the East, South, and Middle West.

The success of the potato industry in Aroostook County is due not only to the natural adaptation of the soils and climate, but also to good farming practices. The most up-to-date methods of fertilization, cultivation, spraying, and harvesting (Pl. II, fig. 2) are followed, and maximum yields are obtained with a minimum of labor. No universal system of rotation is followed, but crops are usually changed so that potatoes are not planted in the same field oftener than 1 out of 5 years, except occasionally on rented land. The system in most general use is: Potatoes, 1 or 2 years; grain, usually oats or wheat as a nurse crop, 1 year; grass, including a mixture of clover and timothy, 1 year; and timothy, 1 or 2 years. There is little or no market for the mixed clover and timothy hay, which is fed to stock on the farm. To obtain a market for hay it is necessary to keep the fields in timothy alone for 1 or 2 years. On account of the short seasons it is always necessary to plow the potato land in the fall, in order to plant the crop as early as possible in the spring. Very little time is lost in preparing the seed bed after the snow disappears, owing to the good drainage. The land is usually gone over two or three times with a springtooth or disk harrow. The potato crop receives first attention, and nothing is allowed to interfere with it. The early varieties, including the Irish Cobbler, Triumph (Bliss), and Eureka, are planted first, and the later varieties, including the Green Mountain, Snow, Carman, Norcross, Sir Walter Raleigh, Peachblow, Spaulding No. 4, Pride, and Gold Coin, follow as soon as the planting of the early varieties is completed.

Potatoes have been planted as early as the latter part of April, but most of the planting is done from the 10th to the 25th of May.

[2] "Barrel" is the unit used locally in expressing production and yields, and is equivalent to 2.75 bushels.

It is planned to have all planting done before the 1st of June if at all possible. The crop is all put in with potato planters, which drill in and cover the fertilizer, drop the seed pieces and cover them, all in one operation.

Some barnyard manure is used, but for the most part commercial fertilizers are employed, which in the last few years have been applied at the rate of 1 ton to the acre. The usual yield of potatoes is from 80 to 100 barrels to the acre, though 125 to 150 barrels are produced under favorable soil conditions and seasons, and with heavier applications of fertilizer.

In common with other potato sections in the north late blight is encountered, but this is controlled by thorough spraying with Bordeaux. The spray is applied at the rate of about 50 gallons to the acre, and three to five or more sprayings are required. When it is necessary to kill the Colorado beetle, which commonly gives very little trouble, arsenical poisons are added to the Bordeaux mixture.

The digging season usually begins about the 1st of September and continues into October. Digging is done with 2-horse machines, some of which are now equipped with gasoline engines to aid in propelling the carrier, thus relieving the horses of all labor except the actual pulling of the machine. Tractors are also coming into use. The crop is gathered by hand, 8 to 10 workers being required to keep up with the digger, which frequently covers 4 to 6 acres a day.

The potato crop is often sold from the field, but most of the farmers hold part for advanced prices later in the season, or, as frequently happens, they store the crop until the rush of digging is over and they have more time and facilities to handle or market it. Each farmer or grower has his own storage house for seed stock and surplus crop on the farm. These are built with cement or stone walls underground, with only the roof above. They are provided with ample ventilation and have stoves to regulate the temperature, so as to prevent rotting and freezing. The buyers and jobbers store the potatoes in immense storage houses at the railway stations. By the use of heated cars potatoes may be marketed all winter. These buyers may represent or sell to potato growers in Virginia, the Carolinas, Florida, New Jersey, Long Island, or other potato-growing sections, who obtain the Aroostook stock for seed, or they may represent or sell to the wholesale trade dealing in potatoes for home or table use.

Only the inferior grades of potatoes have been sent to the starch mills during the last few years, while formerly much of the surplus crop was thus handled when prices fell below $1 to $2 a barrel. In 1916 and 1917 most of the starch mills were idle. The banner year for starch production was in 1914, when 20,000 tons were produced in Aroostook County.

One of the chief items of expense in the production of potatoes is fertilizer. In 1879 a total of $6,672 was spent for fertilizer; this had increased to $53,594 in 1889. In 1899 fertilizers cost the growers of Aroostook County $268,700, but this was nominal as compared with the $1,844,568 spent 10 years later, and it is thought the census of 1920 will show at least double this amount. The buying of the fertilizer best suited to the crop is a very important matter. With the cutting off of the European supply of potash a few years ago the fertilizer formulas had to be changed and the amount of potash reduced, or the latter left out altogether. In 1916 the formula most in use contained 5 per cent ammonia, 10 per cent phosphoric acid, and no potash. The formulas used in normal times have analyzed largely 4–6–10, 5–7–10, or 6–8–10, although the 10 per cent potash was considered high and had been reduced to 7 per cent even before the European war. With the radical departure in 1916 it was to be expected that different results would be obtained. During the early growing season the vines were noticed to be very much darker in color than those of other seasons, and the leaves showed a more crinkled surface. These characteristics were much more accentuated on the Washburn loam as compared with the Caribou loam. The vines appeared healthy to the farmer, however, and gave promise of large yields until after the blossoming period, when they seemed to be collapsing and dying off in patches very much like plants affected with late blight. However, it was soon established that blight was not the cause. Careful examination of the field showed that the trouble was more prevalent on the Washburn and Easton types of soil than on the Caribou soils. It was also severe upon the river-bottom soils, where the first diagnosis of "potash hunger" was confirmed. Part of a field had been fertilized with a 4–8–4 mixture left over from the previous year, and the remainder with the 5–10–0 fertilizer sold the present year. Where the potash had been used the plants were normal and gave a yield 115 barrels, but the remainder of the field died prematurely and gave the very low yield 30 barrels to the acre. Similar experiences were reported elsewhere. In 1917 experiments by the United States Department of Agriculture [3] and the Maine experiment station showed similar results where potash was omitted, and proved the point that the reduced yield and premature dying of the potato vine was due to the unbalanced condition of the fertilizer formula.

While potatoes rank first in importance, the acreage of hay and forage crops is twice that of potatoes. The 1910 census shows 157,489 acres in tame or cultivated grasses, of which 138,689 acres were in clover and timothy mixed. Timothy grown alone occupied 17,735 acres. Alfalfa is not grown to any extent, only 36 acres being

[3] Fertilizer Studies on Potash Hunger of the Potato, by Oswald Schreiner. Proceedings of the Fourth Annual Meeting of The Potato Association of America, 1917, p. 40.

reported. Clover alone was grown on 743 acres. Hay and forage crops in 1909 yielded a trifle less than 1 ton per acre. In 1879 there were 76,420 acres in hay, and in 1889, 105,622 acres. The yield of hay varies considerably from year to year, depending somewhat upon the severity of the winters. The quality is generally good, and large shipments of hay, principally timothy, are made annually through Boston, which is the leading market. The crop commands a good price, but the high transportation charges greatly reduce the profits to the farmer.

Next in importance to hay and potatoes is the oat crop, which in 1909 amounted to 2,542,893 bushels from 69,204 acres. The area in oats in 1879 was 20,161 acres, and the production 628,435 bushels. In 1889 the figures increased to 35,732 acres and 1,128,909 bushels. In 1899 oats were grown on 52,617 acres and produced 1,807,435 bushels. Oats and hay enter into the usual rotation, so that the acreage in this grain keeps fairly close pace with that of potatoes. The quantity of oats produced is not sufficient to meet the local demand, and each year large quantities are shipped into the area, for which a good price is paid. The amount expended on the 44 per cent of the farms that purchased feed in 1909 was $217,743. Soils which are not so well suited to potatoes often make good hay and oat land. This fact should be more generally recognized.

Next to oats, buckwheat is the most extensively grown of the grain crops. The census of 1880 showed 15,009 acres in this crop, with a production of 296,793 bushels. The acreage that year exceeded the area in potatoes by 1,000 acres. In 1889 the production was increased to 388,037 bushels from 18,401 acres. The census of 1900 showed a similar increase, the area seeded amounting to 21,162 acres, but the production was only 385,370 bushels. The census of 1910 showed a very marked reduction in both acreage and yield, the crop occupying 11,685 acres and producing 231,026 bushels. The buckwheat is ground into flour of excellent quality and is used very extensively locally, particularly by the French and Swedes.

Wheat, barley, and rye, named in the order of their importance, have always been grown to some extent, and the increase in the wheat and barley acreage has been in keeping with the increased production of other crops. Rye has shown a steady decrease until it has ceased to be an important crop. Barley showed an increase up to about 1905, since which year it has apparently declined in popularity. The acreage devoted to wheat has fluctuated from 8,286 acres in 1879 to 1,910 acres in 1889, 5,759 acres in 1899, and 3,036 acres in 1909. The yield has averaged between 20 and 25 bushels per acre.

Although the climate is too severe for many fruits, the hardier varieties of apples, raspberries, blackberries, strawberries, currants, and plums may be grown. Of the apples the Oldenburg (Duchess of Oldenburg), Wealthy, Fameuse, and Dudley (Dudley's Winter) are

the most successful varieties. Small orchards are found on the larger farms in all sections of the county. The fruit, though not of as good quality as that grown in some sections, meets the local requirements, and the quality might be improved if more attention were given to the orchards. The value of the orchard products in 1879 was $7,227 and in 1909 $78,544. Raspberries, strawberries, and blueberries, or huckleberries, of fine quallty grow wild in extensive areas and are the main source of fruit for local canning purposes.

Vegetables are grown on almost every farm, mainly for home use. The season is often too short to make vegetable production a profitable industry, but more attention should be given to the gardens and to the canning of the vegetable products. Beets, turnips, lettuce, cabbage, carrots, parsnips, peas, beans, radishes, and onions can all be grown successfully. The season is generally too short to mature tomatoes, but they might be successfully grown in cold frames and greenhouses.

The value of the poultry raised is given in the 1900 census as $65,002. The census of 1910 shows an increase to $254,454. The poultry products are consumed locally, and the supply is not equal to the demand. Poultry farming could be extended with profit if more grain crops were grown.

Aside from supplying the needs of the town and village markets, dairying is not carried on in this area to any extent. Formerly several cheese factories producing an excellent quality of cheese were in operation, but cheese making has been abandoned, since the production of potatoes has become so much more profitable. Practically every farmer, however, keeps enough cows to furnish the family with milk and butter, and any surplus of the latter is disposed of in the local markets. The value of the dairy products in 1899 is given by the census as $285,983, exclusive of those used in the home. The census reports a value of $439,658 for 1909. Associated with the growth of dairying is the development of the entire live-stock industry. The high prices paid in recent years for live-stock products and the increased cost of fertilizer are bringing about a system of farm management that depends more upon the maintaining of the soil fertility through better rotation of crops and the more liberal use of stable manure. The census reports the value of live stock sold or slaughtered as $394,641 in 1899 and $837,605 in 1909, an increase of more than 100 per cent in the 10-year period. Many of the farmers still buy their supply of meat from the town markets, which depend principally upon the West for their supplies. The domestic animals sold or slaughtered in 1909 included 3,915 calves, 7,455 other cattle, 1,709 horses and mules, 17,832 hogs, and 23,805 sheep.

The census reports $37,289 worth of wool sheared in 1909. No extensive herds are to be found, but a small number of sheep are kept

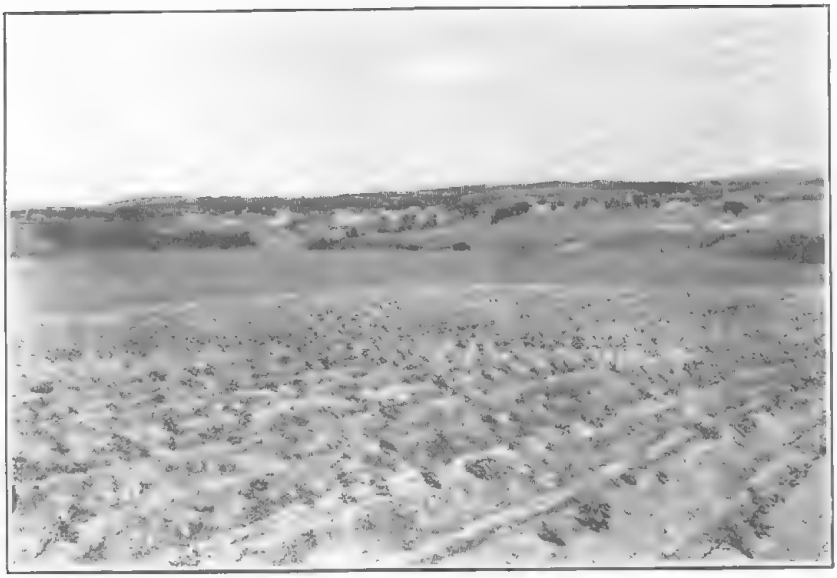

FIG. 1.—BIRD'S-EYE VIEW OF HOULTON, SHOWING THE GENERAL TOPOGRAPHY OF THIS PART OF THE AREA.

The Caribou loam is the predominating type of soil. In the foreground is a field of potatoes on Caribou fine sandy loam, in an early stage of growth. Note the high ridges, a typical feature of potato culture in this region.

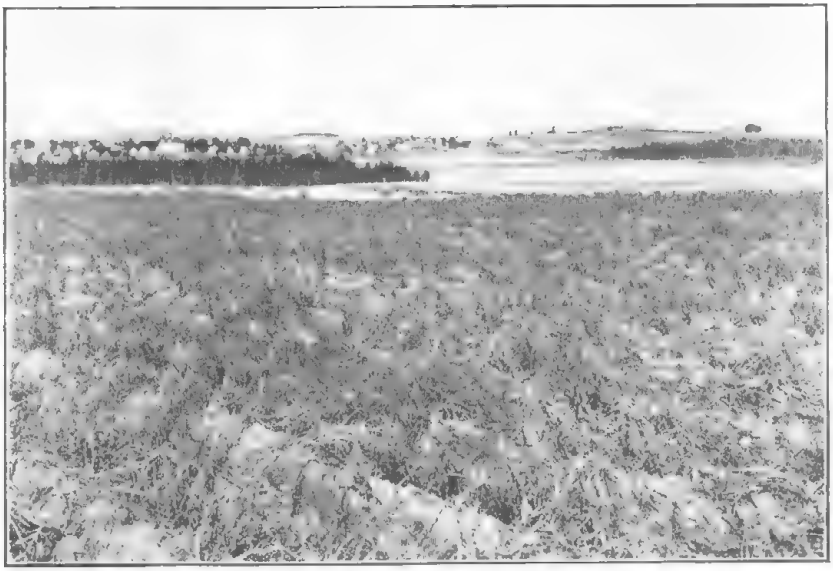

FIG. 2.—OVERLOOKING THE TOWN OF PRESQUE ISLE.

This shows the topography of the Caribou loam, the predominating soil type. In the foreground is a field of Green Mountain potatoes ready for digging.

FIG. 1.—HARVESTING IRISH COBBLER POTATOES ON CARIBOU LOAM.

Both horse-drawn and tractor-drawn diggers are shown in use.

FIG. 2.—A FIELD OF IRISH COBBLER POTATOES FERTILIZED IN 1916 WITH 5-10-0 FERTILIZER AND GROWN UPON TWO TYPES OF SOIL, CARIBOU LOAM AND WASHBURN LOAM.

Note early collapse of plants upon the Washburn-loam part of the field. The picture was taken a few weeks prior to digging.

on most of the farms. Enough mutton is produced to meet the local needs, and some is available for export.

Probably no finer work horses are to be found anywhere in New England, if in the entire country, than in this area, and a large percentage of them are home raised. Fine driving and racing horses were kept at one time, but the automobile has almost supplanted the driving horse, though racing with cutters is one of the winter sports.

Forest products have always been one of the principal sources of income in this area. They come mainly from that portion of the county outside the area surveyed, but the returns accrue largely to those residing within it. Most of the lumbering is done in the winter months, when the timber in the swamps is more accessible and teams and laborers are available in larger numbers.

There has been no selection of soils on a basis of their crop adaptation. The better drained soils were naturally cleared first and, as it happened, proved to be the better soils generally for potatoes. Potatoes and grasses are grown on nearly all the types, but it is generally recognized that while the dark-colored soils are especially well adapted to grass and grain crops they are not so well suited to potatoes. The latter do better upon the soils of the hardwood ridges. The river soils are rated as the best for grass, but the sandier types are also used extensively for growing potatoes.

No one system of crop rotation is followed throughout the area, but each farmer adopts the one best suited to his purpose. Those who go into hay making for profit adopt the long-time rotation of one or two years in potatoes, one year in grain, and two or three years in grass. This gives one year of mixed clover and timothy hay and two years of timothy alone. The average rotation is one year potatoes, one year grain, and two years hay. For largest yields of potatoes it is best to turn under a heavy aftermath of clover the second year following potatoes, which aids materially in renewing the organic matter that is so rapidly depleted under the more intensive cropping system. The intensive system should be supplemented by stock raising or dairying. This need not prevent the planting of the usual acreage to potatoes as the two industries can be carried on jointly, frequently without the aid of additional farm help, and such a system of farming should materially reduce the fertilizer bill. As in the case of all one-crop systems of farming, there are poor crop years when the farm is operated at a loss, and if dairying or live-stock raising were included in the operations the loss might be at least partially offset.

The land when first cleared is usually thickly strewn with rocks or bowlders of varying sizes, but these are removed so that labor-saving machinery can be employed. Riding or sulky plows, plant-

ers, mowers, diggers, graders, hay loaders, and manure spreaders are used on most of the farms. Preparation of the seed bed is done mostly with the 2-horse sulky plow and disk harrow, and is deep and thorough. Each turning up of the soil brings new stones to the surface, which are carried to the "dump" either in the late fall or early spring. Planting, fertilizing, cultivating, spraying, and harvesting of the potato crop as well as of oats, wheat, buckwheat, rye, barley, and hay, are all done with labor-saving machinery, except where the latter crops are grown in new stump land and have to be cut with a scythe. Tractors for plowing and trucks for hauling are rapidly coming into use on the larger farms.

Before the process of clearing the land is begun most of the merchantable timber is cut and marketed. The remaining growth is cut up into wood, which may also be sold off or kept for home use. This work is done mostly during the winter months. In the early spring the brush is piled and burned and the land plowed and seeded to clover and timothy. Sometimes the hay is cut with a scythe, but more often it is left for pasture. After a few years, when the stumps have had time to rot sufficiently the smaller ones are "snagged" out by horse power, while dynamite is used to blow up the larger stumps. The cost of clearing the land can frequently be paid out of the sale of the timber removed.[4] Sometimes the land is first seeded to oats, but an increased acreage for potatoes is generally the object in view in clearing. Plate III, figure 2, shows newly reclaimed fields along the forest border.

The total number of farms in the county in 1879 was 5,802, with an average of 125 acres per farm. In 1889 the number had increased to 6,180, with an average of 117 acres per farm. In 1910 there was a total of 7,289 farms, with an average size of 118.6 acres.

The value of all farm property per farm increased from $1,148 in 1879 to $6,067 in 1909. In the latter year the land represented 57 per cent of the total value, buildings 24.5 per cent, implements 7.5 per cent, and domestic animals 11.1 per cent.

The census of 1880 showed 96.5 per cent of the farms operated by owners, and the census of 1910, 95.7 per cent. Probably no section of the country shows a smaller reduction in owner-operated farms during the last 30 years. This accounts largely for the prosperous agricultural conditions.

SOILS.

The soils of Aroostook County are derived directly through the weathering of glacial till. During the glacial epoch this region was covered with a slowly moving ice sheet of great thickness, which

[4] It is generally estimated that on the hardwood ridges there is 1,000 to 2,000 feet per acre of spruce in addition to the yellow birch and beech, all of which command a ready market for lumber and firewood as well as for other purposes.

wore down the ridges and filled in the valleys as it crept along. Some of the material was "ground" along underneath the ice, while part of it was transported with the glacier. The material apparently was transported but a short distance, as it seems to be derived from the underlying rock, or from similar rock found only a short distance to the north. The rock from which most of the till is derived is the shaly Aroostook limestone. This sometimes outcrops at the surface but in other places is buried as much as 25 to 30 feet by till. The average depth, however, is from 2 to 6 or 8 feet.

Small areas in the area are underlain by other rocks, of which small outcrops occur. These include the conglomerate and diabase of Mars Hill; the Mapleton conglomerates, sandstones, and granites; the Chapman sandstones; the trachytes of Edmond and Hobart Hills; and the quartz trachytes of the Quaggy Joe region. Of these the only ones that have influenced the soils to an appreciable degree are the sandstones and conglomerate, which, where they are near the surface, modify not only the texture but also the color of the overlying material. In addition, there is a small area extending nearly north and south, in Chapman and Mapleton Towns, underlain by arenaceous limestones.

The recession or melting of the glacier left a covering of unassorted coarse and fine materials over the entire area except the morainic sections, where the materials are more or less assorted and roughly stratified. The deeper unweathered till consists of a compact, grayish silty material containing a variety of rounded stones and gravel, while the surface part of the till is more uniformly a silty loam containing numerous shale fragments, with small rounded stones in places. Owing to the various processes of weathering, and the accumulation of organic matter through the decay of vegetation, the surface or weathered part of the till is brown in color, while the deeper till is grayish. Oxidation and chemical reaction, which are continually taking place in nature, are also responsible for the change of color. The siltier or finer texture of the surface till is due mainly if not entirely to the disintegration of the softer shale and shaly limestone fragments by the processes of weathering, most of which are vigorously active in this climate.

At the close of the glacial epoch the surface is believed to have subsided and the climate to have become warmer. Subsequently to the disappearance of the ice swift-flowing streams were formed which partly filled in the Aroostook and other valleys, forming the second terraces along the several streams. Following this there took place either an elevation of the country or a cutting through of the streams to form their present channels, along which the first bottoms are still in the process of formation.

The area as a whole is comparatively free from large bowlders, although some with diameters of 10 to 12 feet occur. The largest ones were observed in the vicinity of Houlton. The newly cleared lands are always stony, and part of the labor involved in preparing the land for cultivation is the carting off of these stones. They vary in kind from sandstone and shaly limestone to granite and conglomerate.

The largest moraines of the area lie in a belt partly encircling Houlton on the west and south. The Bangor & Aroostook Railroad passes through a deep cut in this ridge about 1 mile south of Houlton. This cut has been the source of much of the roadbed ballast for the entire system, and there is a supply for many years to come. The surface of these morainic ridges is almost free from stones, and in places, particularly west of Houlton, is quite sandy.

The soils of the area may be divided into three general groups, including those derived from glacial till, those from reworked or alluvial material, and those from organic material. There are two kinds derived from glacial till, one of them developed under conditions of poor drainage; the other under conditions of good drainage. The soils developed under the former conditions are the Washburn loam, Easton loam, and Chapman loam.

The Washburn soils, under virgin conditions, consist of a thin layer of Peat or Muck overlying grayish to mottled gray and brown mineral soils, the color being due to poor drainage and to some extent to the action of the overlying organic material in leaching out the iron or in preventing oxidation.

The Easton soils are light gray to nearly white in color in the surface soil, with bluish-gray or mottled gray and brown subsoils. They have developed in somewhat better drained situations than the Washburn soils but in virgin conditions were covered with a layer several inches in thickness of undecomposed organic débris dry during a considerable part of the year and constituting a dry imperfect Peat or "rokhumus."

The Chapman soils consist of Washburn and Easton types occurring in small areas in intimate association, the individual areas being too small to map on the scale used. It is not a series of soils, but a name applied to mixed areas of other soils not differentiated on account of small areas.

The soil types derived from glacial till and developed under conditions of good drainage include the various members of the Caribou series.

The Caribou soils in virgin condition consist of a light-gray horizon ranging in thickness from a quarter inch to 6 inches. This is underlaid by a brown horizon, changing rather rapidly to yellowish and in a foot or often less to a pale yellowish coffee color. Below this there

is a gradual change to a lighter color, becoming yellow, then greenish yellow and finally pale bluish gray, the color of the native glacial till at about 3 feet. These soils have been derived from glacial till and developed under good surface and subsoil drainage conditions.

The soils of alluvial origin, or those derived from reworked till, include both the first and second bottom lands. The second bottom or terrace soils are classed in the Van Buren and Keegan series, and those of the first bottoms, or overflow lands, in the Aroostook series.

Muck is the only organic soil mapped, although a large percentage of the area included with Muck represents various stages of decomposition of the component vegetable matter. The larger and deeper deposits of Muck include bodies of Peat.

The soil profile produced during the normal development of soils under the climatic and vegetational conditions existing in the northern part of the timbered belt of America and Eurasia is well developed in the virgin soil of the Aroostook country. It consists of a thin surface horizon ranging from ½ inch to 6 or 8 inches in thickness and from gray to nearly white in color. It lies immediately beneath the cover of moss and leaves universally present on the surface within the virgin forest. Beneath this lies a horizon ranging in color from straw yellow to coffee brown and always marked by a characteristic looseness and softness to the feel and lightness in weight. Its characteristics are due mainly to the large amount of organic matter present and to a certain amount of precipitated iron oxide. It is usually higher in its percentage of iron, alumina, and organic matter than the surface horizon. It varies very greatly in thickness as well as in the perfection of its development. In the Aroostook area it is about 15 inches thick on the smooth uplands and thinner on the slopes. The change downward to the underlying horizon is gradual. The latter consists of the unweathered or slightly weathered glacial till, which has a greenish-yellow to grayish color, the former color occurring at the top, where the material has been subjected to slight weathering, the latter at greater depths, where it is unmodified.

This profile does not exist in the cultivated lands on account of the obliteration of the surface gray horizon by plowing. Since this is always thin and since the depth of plowing in the region is rather great, the plowed layer has a much higher percentage of the second or yellow-brown horizon than of the gray. The cultivated soil therefore is yellowish brown, and this color persists downward to the top of the unweathered or slightly weathered drift, or to about 15 or 16 inches on the smooth, well-drained uplands and to a less depth on slopes. The cultivated soil therefore has only two horizons, while the virgin soil has three. The soil descriptions that follow apply to the cultivated soil.

The following table gives the name and the actual and relative extent of each of the soil types mapped:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Caribou loam	389,760	55.9	Aroostook silt loam	3,264	0.5
Muck	112,832	16.2	Van Buren silt loam	2,880	.4
Washburn loam	70,144	10.0	Caribou shale loam	2,496	.3
Chapman loam	57,728	8.3	Van Buren sandy loam	1,088	.2
Easton loam	16,512	2.4	Keegan silt loam	1,024	.1
Caribou gravelly loam	15,040	2.2	Caribou fine sandy loam	704	.1
Caribou silt loam	12,608	1.8	Total	697,600	.....
Caribou stony loam	7,808	1.1			
Linneus silt loam	3,712	0.5			

CARIBOU STONY LOAM.

The Caribou stony loam consists of rough land, which for the most part is too stony for cultivation. The interstitial material of the surface soil is yellowish-brown loam, and of the subsoil, which begins at a depth of 8 inches, yellowish-gray silty loam. On Mars Hill the soil is somewhat more gravelly than typical and has a reddish cast. Small areas of similar character are encountered on Hobart Hill. On Green Mountain the type consists of a shallow mantle of yellowish till, covered by deep vegetable mold, and underlain by quartz trachyte. The Caribou stony loam as mapped includes small outcrops of conglomerate and diabase on Mars Hill, andesite on Hobart and Edmond Hills, and quartz trachyte on Quaggy Joe and Green Mountains. The steeper slopes in each location are strewn with large bowlders.

The Caribou stony loam is not very extensive. It occurs largely in the volcanic area to the south of Presque Isle, and in the vicinity of Drew Lake in the southwestern part of the survey. It occupies areas varying from a few acres to more than a square mile in extent. One of the largest bodies is that on Mars Hill, which is about 1 mile wide and 3½ miles long. Another is in the vicinity of Drew Lake. A belt about one-fourth mile wide extends for about 3 miles, in a north and south direction, along the ridge of mountains of which Green Mountain and Quaggy Joe Mountain are a part. Although the type occupies the higher mountain ridges and peaks, the forest growth protects it from erosion.

The glacial till from which the Caribou stony loam has been largely derived contains some material disintegrated from the underlying rock and some organic matter, the latter coming largely from leaves and other remains of the native growth of yellow birch, maple, beech, spruce, and fir.

None of the type has been cleared, even sufficiently for pasture, but as the demand for land becomes more urgent it is possible that the type will be converted into pasture.

The selling value of this land depends on the forest stand and the accessibility to market. It ranks with the lowest priced land in the area and sells at $2 to $8 or $10 an acre.

CARIBOU SHALE LOAM.

The Caribou shale loam is extremely variable in composition and can best be defined as a mixture of gray, brown, black, and greenish or bluish shale fragments, largely residual from the underlying rock, with varying quantities of interstitial silty loam. The proportion of fine earth varies considerably within short distances. Where the underlying formation appears near the surface there may be only a shallow covering of shale fragments without fine earth, while in other areas there may be a thin covering of drift material containing more true soil. Differences in the hardness of the shale rock also have influenced the quantity of interstitial material, it being much greater where the rock is softer and thicker, as in the case of the grayish shale. These lighter colored shales are often calcareous, which also tends to their more complete disintegration.

Small areas of Caribou shale loam occur most extensively in the southern part of the survey, where the drift is shallower. In many cases the bodies are too small to be separated, but the outcropping ledges can easily be recognized, as they form hummocks upon the surface of the otherwise fairly smooth Caribou loam. Comparatively large bodies of Caribou shale loam lie along the western edge of Littleton and Monticello Towns. A nonagricultural area about 2 miles southwest of Monticello station, classed with the Caribou stony loam, is nothing more than a barren exposure of resistant shales which apparently never received any deposition of glacial drift.

The Caribou shale loam is most characteristically developed on the steeper ridge slopes, where it occupies low, rounded bumps or knolls. For the most part it is excessively drained.

This type is farmed in connection with the associated soils. Where the shale is highly calcareous there results a neutral or alkaline condition of the soil which is favorable to the growth of the common scab organism and causes scabby potatoes. This condition is most marked where the calcareous fragments come in contact with the tubers. Areas of the type in which the shale contains less lime or has weathered more completely approach more nearly the condition of the Caribou loam. Hardwood trees predominate on this type, although in places the soil may be too shallow to support any growth except grasses and small brush.

Yields are lower than those obtained on any of the other Caribou soils except the stony loam. The shale loam if it occurred in large bodies would not command as high a price as the Caribou loam or silt loam, but as it is closely associated with the latter types and usually occurs in the same field, it brings about the same price, $50 to $75 or more an acre, according to the location.

CARIBOU GRAVELLY LOAM.

The Caribou gravelly loam, to a depth of 7 to 10 inches, is a yellowish-brown to dark chocolate brown gravelly silty loam, becoming much darker when wet. It is very loose and mellow and has a rather coarse feel, owing to a relatively high percentage of the coarse grades of sand. The gravel is practically all rounded or waterworn and consists more largely of quartz, granite, and quartzite than is characteristic of the other types of the series, in which fragments of shale predominate. Between 10 and 20 inches there is a gradual change in texture, the subsoil being a mass of rounded gravel and small stones with little interstitial material. The color usually becomes somewhat lighter with depth. In certain "outwash" spots, as on some of the valley slopes, the subsoil to an average depth of 20 inches is a rather compact, yellowish-gray gravelly or shaly loam, similar to the lower subsoil of the Caribou loam. Both the soil and subsoil of the Caribou gravelly loam contain 40 to 50 per cent of gravel and stone, mostly rounded, varying in diameter from a fraction of an inch to several inches. The whole of the substratum is made up of irregularly stratified layers of gravel, gravelly sand, coarse sand, and medium or fine sand.

The Caribou gravelly loam when freshly plowed presents a much darker appearance than the Caribou loam. The color, however, lacks uniformity, numerous dark patches high in vegetable matter and whitish spots devoid of organic matter giving the surface a mottled appearance.

The Caribou gravelly loam is mapped in scattered areas in all parts of the survey. The largest area lies in the towns of Houlton and Littleton and another of notable size on the east and southeast slopes of Mars Hill. Smaller bodies lie in places along the streams. The type occurs both on morainic ridges and knolls, and as outwash deposits. The latter are typified in the valley of the St. John River and in what are apparently preglacial valleys lying north of Mapleton. That part of the type at the east foot of Mars Hill is conspicuously lacking in the morainic knolls or hummocks found so generally over the surface elsewhere. The gravelly loam is closely associated with the loam of the series, and many small bodies too small to map separately are included with the latter.

The Caribou gravelly loam is a loose and mellow soil, easily kept in good tilth, and though not as retentive of moisture as the loam, it is not as droughty as would be expected.

Practically all of the type is planted to potatoes, in rotation with grain and hay crops. It is well suited to potatoes, and yields of 80 to 100 barrels per acre are not uncommon. It is not, however, as well suited to grass and grains as some of the heavier types, and as it is more readily leached of soluble fertilizer, a heavier application is necessary for equal returns. In 1916, when the shortage of potash in the fertilizers was most acute, this type showed more of the symptoms of potash hunger than did either the Caribou silt loam or loam. Plants thus weakened were more readily attacked by bacterial and fungous diseases, and collapsed with early maturity of the crop more quickly than on other soils. In this respect they behaved very much as did most of the crop planted the same year on the Washburn and Easton loams. The Caribou gravelly loam is especially benefited by applications of barnyard manure.

The selling value of this land depends upon its nearness to markets and the nature of the improvements, and ranges from $75 to $100 an acre.

CARIBOU FINE SANDY LOAM.

The Caribou fine sandy loam consists of 8 to 9 inches of yellowish-brown fine to medium sandy loam, underlain by a lighter or paler yellow fine to medium sand. The type varies from one body to another in texture, but averages a fine rather than a medium sandy loam. The sandy subsoil usually extends to more than 3 feet, but in some areas it is displaced at 2 to 3 feet by morainic gravel, which underlies all of the type at some depth.

This is an inextensive soil. The largest area lies about 1 mile west of Houlton, occupying part of the large morainic ridge which begins at the bend in the Meduxnekeag River at Carys Mill, southwest of Houlton, and extends almost due north for 6 or 7 miles. The soil occupying this range of hills is for the most part a gravelly loam, but associated with the gravelly type is the Caribou fine sandy loam, which is comparatively free from gravel.

Owing to its close proximity to Houlton the main body of the type has been a source of gravel and sand for building or road construction purposes, and pits exist from which large quantities of material have been removed. As the demand for this material increases these excavations will doubtless be extended to include a very large part of the type.

This soil produces potatoes of excellent quality, and the yield is about the same as that on the other upland types, averaging 80 to 100 barrels per acre. Oats also do well, but the type is not so well

suited to hay as are some of the lower lying soils which have a larger supply of moisture.

Below are given results of mechanical analyses of samples of the soil and subsoil of the Caribou fine sandy loam:

Mechanical analyses of Caribou fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
100423	Soil	0.6	2.2	1.3	14.7	40.8	34.4	5.9
100424	Subsoil	.1	1.0	1.0	19.8	44.4	29.0	4.6

CARIBOU LOAM.

The Caribou loam is the most extensive and the most important type in the area. The surface soil to an average depth of 8 inches is a yellowish-brown, loose, mellow, silty loam, usually underlain by a golden-brown to rusty-yellow layer of similar material. Interspersed with the silt and other fine materials is from 25 to 30 per cent of gray, brown, and black fine-textured shale fragments, which were originally calcareous, but among which only an occasional one is now found that reacts with acid. Small subangular and rounded stones and gravel, consisting of granite, gneiss, quartzite, and sandstone, also make up part of the soil profile. Most of the larger stones and rocks are removed from the surface at the time of clearing or when the land is first prepared for cultivation, as are also those which are later "heaved" to the surface through the freezing and thawing of the soil. There is usually a sharp boundary in color between the surface soil and subsurface material, but below 12 to 15 inches, the average depth of the latter, the color shades off more gradually from pale yellow or yellowish gray to lighter gray or dull gray to drab. The subsoil also becomes coarser, grading to a silty, sandy, gravelly, or shaly loam. This in turn is underlain at 20 to 24 inches by a rather compact mass of crushed or broken-down brownish to greenish or bluish-gray shales, which may have been part of the bedrock of calcareous shale. This substratum of shale fragments makes it almost impossible in most places to penetrate deeper than 20 inches with the soil auger. Shale from this depth is more often calcareous than that near the surface and effervesces with acid, especially on freshly broken edges. The bedrock is encountered at varying depths, in most places between 6 and 8 feet, but it may outcrop on the steeper slopes, in which case it usually gives rise to another type of soil, the Caribou shale loam. Outcrops do not occur very generally, and they can readily be detected by the presence of mounds. A large body of this rock outcrop, upon which, apparently, no glacial till was ever deposited, lies about 2 miles southwest of Monticello.

Some areas of the Caribou loam closely approach a silt loam in texture, and it is often a matter of nice judgment where to draw the line of separation. This is particularly true of that section lying just to the north of Houlton, and also in the vicinity of Van Buren. Here some silt loam areas are included with the loam, as it is doubtful whether the agricultural difference would warrant any attempt at closer separation. Observation indicates that the type becomes more uniform after long cultivation. This was shown in samples collected for analysis from forested areas, from areas under cultivation for a long time, and from those cultivated for a short period. The virgin samples, or those from the forested areas, have a thin, white, flourlike, silty layer just beneath the leaf mold. This is particularly true of the beech-wood soils. This layer is also frequently noted lying between a shallow surface covering of Muck and the soil of the Chapman loam, where this type is closely associated with the Caribou loam. With long cultivation many of these differences disappear. Freshly plowed, new ground of the Caribou loam usually presents a variegated appearance, white silty spots being particularly conspicuous, while this mottling is not seen in land that has been under cultivation for some time.

In mapping the type on the present scale it is necessary in some places to include small areas of other soils that occur interspersed with it, such as the Washburn and Easton loams. That part of the type along the slopes of the northern half of Mars Hill is somewhat darker in color, as it normally contains more moisture than typical. The type, however, is quite uniform in color throughout its extent.

One of the most important characteristics of the Caribou loam is the ease with which it can be cultivated and the loose, mellow structure which is maintained even if the soil is plowed when wet. This is due no doubt to the fairly low content of clay and the rather high proportion of shale fragments. The structure of the soil makes it especially well adapted to potatoes, as it gives the tubers a better opportunity to expand naturally and grow truer to type, which is particularly to be desired with seed potatoes.

The Caribou loam covers 55.9 per cent of the area surveyed and is found in all parts of the survey. It occurs in one more or less continuous area extending from the St. John River to the extreme southern boundary, dissected, however, by numerous strips and irregular bodies of other widely distributed types. In the vicinity of Mars Hill and Robinsons, it is displaced by the Caribou silt loam, which contains on an average about 10 per cent more silt than the loam. The largest and most typical development of the Caribou loam is in the vicinity of Presque Isle, Caribou, Limestone, and Fort Fairfield. The type occupies for the most part the broad, level to undulating ridges which extend for miles as watersheds between the various

drainage ways. It also occupies, in association with smaller bodies of the Washburn and Easton loams, the ridge slopes which descend very gradually in gentle undulations nearly or quite to the narrow stream bottoms. (See Pl. IV, fig. 1.) The topographic position insures good drainage throughout the year, and this no doubt accounts for the highly oxidized condition of the soil and its rich yellowish-brown color.

The Caribou loam represents glacial deposits which have weathered rather uniformly to an average depth of about 18 inches. This is perhaps the most uniform soil mapped. In measuring the acidity of this type and the Washburn loam it was found that a wide variation occurred between samples of the latter, while with the Caribou loam the range of difference was small. Unless treated artificially with lime or some other correcting agent, the acidity of the Caribou loam is in most cases inhibitive to the growth of the scab organism, while with the Washburn loam the opposite condition exists. The inclusion in the fields of former sites of manure piles, ash or plaster dumps, or straw stacks may cause the potatoes locally to scab, but without contamination of this sort the Caribou loam produces potatoes of good color and excellent quality, free from scab. In 1916, when no potash was used in most of the brands of fertilizer, the effects of potash hunger were much less acute on this type than on the Washburn loam. The foliage characteristics showed the lack of potash, but the plants did not collapse during the growing period, and were therefore not attacked by bacterial and fungous diseases as they were in a large percentage of the fields on the Washburn loam. They maintained their vigor throughout the growing season and produced a fairly normal crop, while the yield on the Washburn and Easton soils was generally low. Also these latter soils yielded a predominance of small potatoes, which would have gone to the starch factories had not there been a demand even for such inferior stock at a fairly good price. Experiments conducted by the U. S. Department of Agriculture and the Maine experiment station show that potash used in the fertilizer up to 6 per cent is a profitable investment. The average fertilizer used in 1917 analyzed 4 per cent ammonia (NH_3), 8 per cent phosphoric acid (P_2O_5), and 4 per cent potash (K_2O), and was generally applied at the rate of a ton to the acre. Potatoes are the chief money crop on this soil, though hay is also a source of income. Potatoes yield 90 to 100 barrels per acre in normal seasons, and 125 barrels or more are frequently obtained.[5] (Pl. IV, fig. 2.) The crop is largely shipped out of the area, and commands a good price in outside markets both for seed and for table use. The price in 1916 and 1917 averaged around $3 and

[5] In 1919 a yield of 175 barrels per acre was obtained. This field had been fertilized with commercial fertilizer and a heavy application of barnyard manure.

$3.50 a barrel, and part of the crop brought as much as $8 or even more. Prior to the period of war demands the ordinary price was around $1 or $1.25 a barrel. Hay does well on this soil, but the yields, particularly of clover hay, are not generally as heavy as on the Washburn and Easton soils. Oats do well, yielding 50 to 60 bushels per acre.

The usual rotation on this soil consists of one or two years potatoes, one year of grain serving as a nurse crop for grass, and two years hay. The clover hay is usually fed on the farm or sold locally. The timothy, which follows the clover, finds an outside market. Through this rotation and with the very liberal use of commercial fertilizers the productiveness of the soil is apparently well maintained.

As this soil is highly adapted to potatoes, which are the chief cash crop, it is only natural that the best farms in the area are located upon it. The greater proportion of the type is in cultivation, and the rest is rapidly being brought under the plow. Forested areas sell for $15 to $20 an acre, according to location, while improved farm lands are held at $75 to $150 and $200 an acre. Those close to the towns and well improved, if for sale, would command even a higher price.

CARIBOU SILT LOAM.

The Caribou silt loam consists of 8 to 10 inches of yellowish-brown to hazel-brown silt loam, underlain by brighter yellow material which extends to 12 or 14 inches. At this depth the material gives way to a grayish silty loam, which in turn is underlain at depths of 6 to 10 feet or more by calcareous shale or shaly limestone. Many shaly-limestone and shale fragments and a few small fragments of other rock formations occur throughout the soil profile, but they are much less abundant than in the associated Caribou loam. Unlike the condition in the other soil types, the stones in the silt loam subsoil are nearly all fragments of Aroostook limestone. Similar stones are found in the surface soil, but fragments of other formations are also present. The type has so many characteristics in common with the Caribou loam, and the two grade so imperceptibly into each other, that it is often difficult to draw definite boundaries between them. The loam, however, carries more stones and shale fragments. In the silt loam occurring northeast of Mapleton the subsoil is much stiffer than that of the Caribou loam in this section, being a silty clay to silty clay loam which extends to 3 feet or more.

The Caribou silt loam is found principally in Easton, Mars Hill, Blaine, and Bridgewater Townships. A few smaller areas are found in the extreme northwestern corner of Perham Township, west of Hanford. The main body of the type lies around Mars Hill and

Robinsons, extending almost to Bridgewater Center. It occupies ridges, slopes, and well-drained flats, but on the whole is somewhat lower lying than the Caribou loam.

The original forest growth, and that found in the forested areas at the present time, includes such hardwoods as yellow birch, beech, maple, and scattered spruce and fir. Practically all of the type is under cultivation. It is an excellent potato soil, and is used mostly for this crop. The tubers are of excellent quality, and yields range from 50 to 90 or 100 barrels per acre. In some cases yields considerably larger have been obtained. The crop is fertilized at the rate of 1,200 to 2,000 pounds per acre. Grain crops give good results on this type, and it is well adapted to acclimated fruits and vegetables, although only a small acreage is devoted to these. Large quantities of hay are produced. The yield ranges from 1 ton to 1½ tons per acre. The average yield of oats is between 45 and 50 bushels.

This type is well located and is generally well improved, and farms bring $90 to $100 or more an acre.

WASHBURN LOAM.

The Washburn loam, though of the same origin as and closely associated with the Caribou loam, shows little similarity to the latter type. The surface soil, instead of being yellowish, is dark gray to brownish and in places almost black. To an average depth of 7 or 8 inches it is a silty, shaly loam. The subsoil is in most places a dull gray, rather compact, silty loam. Where the drainage is better developed the subsoil may be grayish yellow, mottled with brown, while in areas grading imperceptibly into the Caribou loam it may not be unlike that of the latter type. Below 18 to 20 inches the subsoil is less loamy and compact and contains a much higher percentage of greenish to bluish-gray shale fragments, quite similar to those found in the substratum of the Caribou soils.

The dark color of the surface soil of the Washburn loam is due to the incorporation of organic matter, and the depth of the dark color is in direct proportion to the content of plant remains. In the virgin state the type is covered with a mucky layer varying from a few inches to 1 foot or more in depth. A large part of this mucky layer is burned off in clearing the land, and what remains is incorporated with the surface soil by plowing and tillage. Leaching of the finer particles from the overlying muck has also had a part in causing the dark color of the surface soil.

The Washburn loam in the virgin state probably had a larger proportion of stones upon the surface than the Caribou loam. As in the case of the latter type, these consist of granite, gneiss, and sandstone. They vary for the most part from 5 to 18 or 20 inches in diameter, but there are occasional large bowlders.

This type, like all the other glaciated soils, contains a rather high percentage of slate and shale fragments. These impart to the soil a coarse feel, but its structure is very different from that of a typical gravelly loam in which the rock fragments ordinarily consist of subangular and rounded hard quartzite and granitic pebbles instead of the softer, flaky shale fragments which are continually breaking down into the finer silty material.

After the removal of the rocks and bowlders, the Washburn loam is as easy to cultivate as the Caribou loam, provided the drainage is adequate or cultivation is done at the time of the year when the moisture content of the two soils is about the same. Seepage from the adjoining higher soils generally settles in the basins occupied by the Washburn loam, causing it to be saturated and even boggy in the lower situations in the spring of the year. Heavy rains during the growing season may also affect these areas, but the average rainfall is not sufficient to injure crops. Naturally, when the soil is supersaturated it is not easy to cultivate, but it is only in wet, late seasons that much difficulty is encountered with cultivation. Such condition rarely if ever exists in the Caribou loam.

The Washburn loam occurs in scattered areas over the entire survey. The extremely well drained watersheds are almost the only sections where farms do not include more or less of the type. It occupies dips, basins, or valleys where drainage has been by any means intercepted and Muck has formed from the remains of an aquatic vegetation. The type is chiefly found in the valleys where the drainage outlets are not sufficient to carry off at all times of the year the run-off and seepage from the ridges. This imperfect drainage exists at or near the foot of the long, sloping ridges previously described as characteristic of the area. It is also characteristic of these slopes that if one side or slope of the ridge is particularly free from these wet seepage spots, the opposite slope shows an abundance of them, ranging in size from a few square yards to several acres. Where the basins or valleys are sufficiently deep to allow considerable Muck to accumulate, the Washburn loam is developed where the slope is long and gradual, or where the Muck is shallow. Where the Muck is 2 feet or more in depth the underlying material apparently has undergone such changes that it could not be correlated as Washburn loam, even were the Muck to be burned off or removed. The underlying material in these deeper Muck swamps resembles a low grade of marl.

A very large percentage of the Washburn loam remains in the dense native forest, which includes cedar, fir, spruce, and tamarack, with some poplar and white birch. The latter usually comes in when the original forest is destroyed by fire. Despite its common

origin with the Caribou loam, this soil has been so modified that it supports a different native growth from the Caribou.

For potatoes this soil has a lower value than the Caribou loam, but forage crops and grains, especially oats, seem to do better. Its disadvantages for growing potatoes are the prevalence of scab and its tendency to be wet at planting time. Tests in the laboratory show a different acid reaction from that given by the Caribou loam, the Washburn in most cases being much less acid, or even approaching neutrality, a condition particularly favorable to the growth of the common scab.[1] In the Caribou loam, unless artificially altered, the acid reaction is sufficient to inhibit infection by the scab organism. Field experiments during the war period, when potash was scarce, have also shown that potatoes on the Washburn loam suffer more acutely from potash hunger than on the Caribou. This has been shown particularly in seasons of very hot weather followed by heavy rainfall, such as was experienced in this region in 1916. Potatoes on the Washburn soil collapsed very early in the season, were subject to attack from bacterial and fungous diseases, and produced a very poor crop, while plants on the Caribou loam receiving the same fertilization and cultivation were so little affected by potash hunger that an average crop was harvested. However, where 3 to 4 per cent of potash was applied in the fertilizer, or where stable manure had been used with no potash fertilizer, the growth of the plants was fully maintained on the Washburn loam, and a normal crop harvested.

In normal seasons the yield of potatoes on the Washburn loam approximates that of the Caribou loam, but yields vary more widely from one season to another than on the Caribou. Yields of hay and oats are generally greater than on the Caribou soils. Hay yields 1½ to 2 tons, and oats 40 to 50 bushels per acre.

Since more work and expense are involved in clearing this type, and as the main object in acquiring more land is to extend the acreage in potatoes, the Caribou loam is cleared first and the Washburn loam is more often left in its native forest, or cleared only sufficiently for pasture. However, this type will come more and more into use, probably as hay and pasture land in conjunction with the extension of the stock industry.

The present selling value of this land varies from $5 to $10 an acre in the more isolated and heavily forested bodies, to $80 or $100 an acre in the more highly developed sections where it occurs in association with the more desirable, better drained soils.

[1] Hydrogen-ion Soil Type—Common Potato Scab. Louis J. Gillespie and Lewis A. Hurst. Soil Science, Vol. VI, No. 3, Sept., 1918.

FIG. 1.—FIELD OF IRISH COBBLER POTATOES ON CARIBOU LOAM AND WASHBURN LOAM, USED FOR THE FERTILIZER RATIO EXPERIMENT IN 1917, TO STUDY THE EFFECT OF MIXTURES OF POTASH AND NONPOTASH FERTILIZERS UPON THE TWO SOIL TYPES.

In the blossoming stage they show no lack of potash other then a difference in intensity of green color and crinkling of leaves, which is characteristic of nonpotash fertilizers. Later in this field there was the same premature collapse of plants on the Washburn loam as in Plate II, fig. 2, where no potash was used in fertilizer mixtures.

FIG. 2.—GENERAL VIEW OVERLOOKING THE "BIG WOODS."

In the foreground are fields recently reclaimed from their forest cover. There is a continual though gradual encroachment upon the vast forested areas.

FIG. 1.—VIEW OF COUNTRY BETWEEN CARIBOU AND WASHBURN, SHOWING TOPOGRAPHY OF CARIBOU LOAM.

FIG. 2.—A FIELD OF IRISH COBBLER POTATOES ON CARIBOU LOAM.

This field yielded more than 160 barrels per acre. Both barnyard manure and commercial fertilizer were applied to the land in growing this crop.

The following table gives the average results of mechanical analyses of samples of the soil, subsoil, and lower subsoil of this type:

Mechanical analyses of Washburn loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
100421, 100429.....	Soil.....	1.8	6.1	3.1	9.2	13.2	49.3	17.3
100422, 100430.....	Subsoil.....	2.9	4.6	2.2	6.9	17.6	49.8	15.9
100431.....	Lower subsoil.	2.6	4.8	1.8	6.4	18.0	46.8	19.9

CHAPMAN LOAM.

The soil mapped as the Chapman loam really includes patches of all the upland types, as each area embraces two or more variations. The extreme variability is due to the uneven surface, which is marked by hummocks rising as much as 1 foot or more above the intervening depressions and ranging in diameter up to 10 feet or more. The surface soil on the hummocks approaches in character the Caribou loam, while that in the depressions may either be light colored, like the Easton loam, or have a dark surface soil similar to the Washburn loam. Where deepest and most poorly drained they may be partly filled with Muck and Peat.

The surface soil of the more elevated hummocks is usually a light-yellow or bright-yellow to brownish, rather coarse silty loam with intervening patches or pockets of gravel, fine white silt, or dark-colored sand. At depths between 8 and 12 inches a rusty-yellow layer of material similar to the surface soil occurs in many places. Below this depth the yellowish color gradually gives way to the gray or greenish, unweathered till. The subsoil is heavier or stickier than is typical of the Caribou loam. Where the hummocks are only slightly elevated the surface soil is heavier, lighter colored, and the subsoil decidedly sticky.

The soil of the depressed areas between the hummocks varies from a whitish silty loam to a dark-brown to black loam or even Muck. The subsoil below 7 to 8 inches is dull gray to greenish gray, similar to that underlying the hummocks, except that the layer from 8 to 12 or 15 inches is also light colored. The subsoil under the depressed soils is mottled except in the better drained bodies.

The Chapman loam if mapped in very close detail would probably be separated into the Caribou loam, Easton loam, Washburn loam, and Muck. It occupies for the most part the flatter upland situa-

tions where the natural drainage is not so well established as on the associated Caribou loam. When plowed for the first time the fields show the inadequate drainage and consequent lack of uniformity of soil in the various color mixtures of yellow, white, greenish gray, and black. The soil when wet is not as easy to cultivate as the Caribou loam, but it can be put in fairly good tilth.

The largest areas of Chapman loam are mapped in the northern and northeastern part of Limestone Town, in the southern part of Caswell Town, and in the eastern half of Chapman Town. Smaller bodies occur throughout the area, principally in the vicinity of stream courses. The type is usually found at the sources of streams, or in flat areas along streams. The areas are known locally as "blueberry bogs," though they are seldom wet enough to be boggy. The hummocky surface has undoubtedly been produced by the upturning of trees, the burning out of stumps, and winter heaving. The forest growth is mixed, but consists mostly of the softer woods, including spruce, fir, cedar, tamarack, white birch, poplar, and alder. The lightness of the growth is no doubt due to the burning off of the "blueberry bogs" every few years to increase the yields. The berries are a source of considerable income, and a large supply is used for local consumption and for canning.

Very little of this type is under cultivation. It is well suited to pasture and hay grasses and grains, but the existing demand is chiefly for better potato-growing soils, and the Chapman loam is valued mainly for its timber. Many of the natural deficiencies of the type are corrected by cultivation. It sells for $10 to $25 or more an acre. Cleared areas sell for $50 to $60, depending upon the location and the proportion of other soils included.

EASTON LOAM.

The Easton loam differs from the Washburn loam chiefly in its light-gray to nearly white surface soil. Like the Washburn loam, it occupies swales or depressions in the upland. The surface soil to a depth of 8 to 10 inches is a light-gray to whitish silty loam, underlain by a mottled gray and yellow silty loam or loam. The subsoil is less mottled and yellower in the lower depths. Very frequently a layer of sticky yellow clay is encountered at 20 to 30 inches. This type, like most of the other soils, carries a number of angular glacial rocks and bowlders upon the surface, and a rather high content of rock and shale fragments throughout the 3-foot section, but particularly in the subsoil.

The whitish appearance of the surface is due either to leaching or to the nature of the vegetation. The darker Washburn loam sup-

ports a dense growth of cedar which keeps the surface moist the greater part of the year, favoring the accumulation of Muck, while the vegetation upon the Easton loam is more often low shrubs, vines, and moss, with a scattering growth of tamarack, spruce, fir, cedar, poplar, and white birch. These areas are frequently referred to as "blueberry bogs," and they are burned over every few years to obtain larger yields of berries. Thus very little organic matter is left, and what does accumulate is in the form of Peat rather than Muck and is readily ignited by the fires. In very wet places the native growth may be largely alder, with occasional spruce or fir, or the land may be grown up in young poplar, cottonwood, and white birch.

On account of its poor drainage and lack of organic matter, the Easton loam is not as productive as the other upland soils. It is "cold" and wet in the spring, and the germination of potatoes and other crops is consequently retarded. The type is also more readily affected by drought.

The Easton loam is quite widely distributed, but it is most extensive through the central part of the survey, principally in the towns of New Sweden, Caribou, and Presque Isle. The areas are irregular in shape and vary in size from a fraction of an acre to 1 square mile or more. There are very few farms, unless extremely well drained, that do not include at least a small acreage of the type.

The Easton loam shows less alteration from the original glacial drift than the Washburn loam, aside from its color. It probably represents the other extreme of oxidation from the Caribou series, with its brighter yellow surface soil.

When properly drained the Easton loam produces fair yields of potatoes, but yields are not as large as those obtained on the better drained soils, nor are the tubers of as good quality. Tests made for acidity show that potatoes grown upon this soil may be subject to infection from scab, and observations in the field confirm this, although in general it is contended that soils which support a growth of blueberry are very acid and should therefore inhibit the growth of the scab organism. Oats do well on this soil, but it is best suited to hay and pasture grasses.

Probably no soil in the area will be more improved by the use of stable manure than this type, as it is much in need of organic matter. It also lacks good drainage, and this must be provided if normal yields are to be maintained.

The selling value of this land is dependent largely upon its extent and proximity to market. Where it occurs in small areas with the Caribou loam it has a high selling value, but where it occurs in large areas it is often neglected and has a comparatively low sale value.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Easton loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
100406	Soil	3.9	8.0	4.8	14.0	13.6	41.6	14.2
100407	Subsoil	8.6	13.2	7.6	20.4	11.6	28.8	10.2

LINNEUS SILT LOAM.

The Linneus silt loam consists of 8 or 9 inches of dark-brown to grayish-black, loose, mellow silt loam, underlain by a grayish-brown silty loam to clay loam. The change in texture from soil to subsoil is very gradual and in places almost imperceptible. The type is comparatively free from shale fragments, but where they do occur their color is very dark brown to black. Associated with the type as mapped is a lighter brown, silty variation which is apparently of similar origin and almost identical except for the lighter color. It seems to be intermediate between the Caribou loam and the Linneus silt loam. Depressions also occur in the type in which the soil is rather heavy and black and resembles the black prairie soils of the West. Small areas of Washburn loam mapped with this type are much darker and heavier and are practically free from shale fragments.

The Linneus silt loam occurs almost exclusively in New Limerick and Linneus Towns, with a slight extension into the extreme northwestern corner of Hodgdon Town and the southwestern corner of Houlton Town. It occupies the watershed between the stream heads tributary to the south branch of the Meduxnekeag River, and lies close to the base of the mountains surrounding Drew Lake. Its position between these and the mountain just south of Nickerson Lake is suggestive. Although the type occupies comparatively high ridges, its position with reference to the mountains is somewhat that of a valley. The presence of the blue limestone immediately underlying the silty material seems to indicate that it may have played a part in the formation of the type. About one-half mile south of the Henderson School, in Littleton Town, a small area at the brow of the ridge just above a drainage cut leading to the Meduxnekeag River appears to be residual from the underlying limestone, but this area does not cover more than an acre and is not outlined on the map.

This is an especially productive soil. Potatoes reach 110 barrels per acre, while oats frequently yield 50 to 60 bushels. The type is also well suited to grass. It is said that the potatoes are darker in color

than those grown on the Caribou loam, owing to stain from the darker color of the soil. The effect is particularly noticeable in wet seasons. It is also stated that potatoes grown upon this type and afterwards used for seed on the Caribou loam gave better yields than those grown upon the same soil. Potatoes in general, however, do better if the soil is changed.

Below are given the results of mechanical analyses of samples of the soil and subsoil of the Linneus silt loam:

Mechanical analyses of Linneus silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
100411	Soil	1.8	3.2	1.6	6.0	6.0	65.8	15.6
100412	Subsoil	1.6	3.2	1.6	5.8	12.8	66.6	8.6

VAN BUREN SANDY LOAM.

The surface soil of the Van Buren sandy loam varies in depth from 6 to 10 inches and in texture from a relatively fine sandy loam, high in silt, to a medium sandy loam. Its color is yellowish brown to dark brown, though in places, when dry, it appears grayish at the surface. The subsoil is for the most part a dark-gray to drab or greenish-gray, loose, medium to fine sand, containing small particles of calcite, quartz, and mica. The coarser particles are usually water-worn, dark-colored shale, sandstone, and slate fragments. Interlain with the sands of medium and fine texture are occasional lenses of lighter colored silt. At 30 to 36 inches the sandy material is in some places underlain by a compact, yellowish brown clay or a bluish-gray silty clay, both of which are more or less impervious. The sandy layer, however, rests as a rule upon water-worn gravel and coarse sand at varying depths.

This soil is well suited to potatoes, but is not so well adapted to grains and grasses. Its loose, open structure allows free drainage, and it is easy to cultivate.

The Van Buren sandy loam is of alluvial origin and is found on second terraces along the Aroostook River. It is of very small extent and can not be classed as an important type agriculturally.

VAN BUREN SILT LOAM.

The Van Buren silt loam to an average depth of 8 to 10 inches is typically a brown silt loam, varying in places to a fine or very fine sandy loam. This is underlain by lighter brown material of similar texture, which grades into a dull-gray to drab fine sandy loam and at 18 to 20 inches into a loose or incoherent fine to medium sand, streaked in the lower depths with rusty brown. The sandy stratum

sometimes alternates with heavier layers, and in many places at 30 to 36 inches coarse sand and gravel are encountered.

Where the brown surface soil is shallow the texture is generally heavier, and below 6 to 7 inches the soil changes very rapidly to a grayish silty material, which at various depths—from 18 to 24 inches—is underlain by the grayish to drab fine to medium sand underlying the remainder of the type. This heavier variation of the Van Buren silt loam occupies flat, more poorly drained situations and is intermediate between the typical better drained soil and the Keegan silt loam, with which it is generally associated. The two are of similar origin.

The Van Buren silt loam occupies part of the second terraces along the St. John River and the Aroostook River. It is most extensive on the Aroostook River opposite the mouth of Salmon Brook, about 1 mile south of Washburn. Here the lower subsoil is made up of sand and gravel. The type occupies the better drained areas of the second bottoms. Its similarity to the Caribou loam in color suggests that it is derived largely from wash from the upland ridges covered by the Caribou soil. It differs very materially in texture, however, as it is free from shale and other rock fragments.

The Van Buren silt loam, being loose and mellow, is easily cultivated, and any clods that are formed, even in the heavier areas, are readily reduced by cultivation. It ranks as the best alluvial soil in the area and is well adapted to potato culture. For the most part it is used for this crop intermittently with grain and grasses, to which it is also well adapted. It is well suited to the production of truck crops and should be used for these where markets are accessible.

The type is practically all cleared and under cultivation. It is well located and commands a good price along with the adjacent soils. Most of the type in the St. John Valley is adjacent to the main public road traversing the valley both above and below Van Buren, which is the leading market in this part of the area.

KEEGAN SILT LOAM.

The Keegan silt loam, to a depth of 8 to 10 inches, is a rather compact silt loam of a medium to dark-gray color. The silty layer continues to a depth of 18 to 20 inches, where a loose, medium to fine sand is encountered. The color becomes lighter gray from the surface downward. Even in the surface soil there is a faint mottling of light gray and brown, and rusty-brown mottling is characteristic of the material in the lower depths. In the low-lying situations, where water usually stands most of the year, the surface 3 to 5 inches may be dark brown or black, as the result of the accumulation of decaying organic matter. In places the lower subsoil is very similar to that underlying the Van Buren silt loam, particularly its heavier variation.

The Keegan silt loam occurs mainly in the St. John Valley, where it occupies the flat or poorly drained situations on the second bottoms or terraces. There is little or no development of first bottoms along the St. John River, and the alluvial soils are largely confined to the Keegan and Van Buren silt loams. Two areas of the Keegan soil occur along the Aroostook River south of Washburn.

The topography of the Keegan silt loam is very flat, and artificial drainage is necessary in most places to fit the land for cultivation. The type is not well suited to potatoes, and can best be used for hay and pasture land. Owing to its small extent it does not rank as an important type. The greater part of it has been cleared and is used almost exclusively as pasture and hay land. Hay yields from 1 to 1½ tons per acre.

Since the type usually occurs in small areas, there are no farms located exclusively upon it, and the selling value is dependent upon the nature of the adjoining types. It is generally situated within a short distance of markets and commands a good price, averaging $75 or $80 an acre.

Results of mechanical analyses of samples of the soil and subsoil follow:

Mechanical analyses of Keegan silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
100417	Soil	0.2	0.8	0.4	0.6	8.9	74.2	15.0
100418	Subsoil	.1	.4	.4	.9	12.0	72.6	13.6

AROOSTOOK SILT LOAM.

The Aroostook silt loam consists of 10 to 12 inches of grayish-brown to dark-brown silty loam to fine or very fine sandy loam, underlain by similar textured but lighter-colored material to about 20 inches, where alternating layers of silt and fine to medium sand are encountered. These gradually become coarser and more sandy to a depth of 30 to 36 inches, where the underlying material gives way to sand and gravel. In some places the siltier material and the interstratified layers of sand and silt may extend to 4 or 5 feet before the gravelly material is encountered, or they may be shallow, as where the area is subject to frequent overflows and erosion. Where the type occurs in large bodies containing depressions, the latter contain soil of heavier or more silty texture, while the soil in the higher places tends toward a fine to very fine sandy loam.

The Aroostook silt loam is found chiefly along the Aroostook River, but a few small islands in the St. John River may properly be classed with the type. It is also found along the North Branch of the Meduxnekeag River. Very small areas are also mapped on

the south branch of the same river in the vicinity of Houlton. The type is almost negligible in extent in comparison with the upland soils. It is confined largely to islands formed in the rivers and to narrow strips along their courses. In many places the first bottoms it occupies are too narrow to map. The type is subject to overflow and is annually inundated at the time of the spring freshets.

The Aroostook silt loam is of alluvial origin, being formed from the more recent deposits of the streams along which it occurs. The permeable nature of its substratum makes it naturally well drained throughout the greater part of the year. Along the Presque Isle Stream it is not so well drained, but here it owes its occurrence to artificial rather than natural forces.

The type is practically free from stones and is easy to cultivate. It requires heavy fertilization, however, to maintain its productiveness. It is particularly lacking in potash. In 1916 potatoes fertilized with a ready-mixed preparation containing as much as 5 per cent ammonia and 10 per cent phosphoric acid at the rate of 1 ton per acre suffered severely from "potash hunger," and were almost a failure, while similar land fertilized with 4 per cent of ammonia, 8 per cent phosphoric acid, and 4 per cent potash produced a normal crop. Fields suffering from the effects of "potash hunger" that year were also attacked by bacterial and fungous diseases, which generally caused the plants to collapse early in the season.[6] Where a large amount of potash or barnyard manure was used, this condition did not exist. With proper fertilization and cultural methods this type usually produces well, and the potatoes are of good quality. Most of the type has been cleared or is naturally free from forest growth, and all the more accessible areas are under cultivation.

The vegetation characteristic of this type, particularly in poorly drained areas, is a coarse swamp grass. On the better drained islands there are found willow and other small growths, or underbrush, with some ash and elm.

The type is generally owned by farmers who also own the uplands adjacent, but where it is sold separately it brings a fairly good price, especially if close to market. It is frequently necessary to ford the river to gain access to the type, and this disadvantage somewhat lowers its selling value. Little of the land under cultivation can be bought for less than $80 to $100 an acre.

MUCK.

The type mapped as Muck is composed of black or dark-brown organic matter in various stages of decomposition, mixed with varying quantities of mineral matter. The composition of the Muck varies

[6] These observations were made jointly by the Division of Soil Fertility and Office of Truck and Forage Crop Disease Investigations, Bureau of Plant Industry, working in cooperation with the Bureau of Soils.

with the depth of the formation. Where shallow, it is always more highly decomposed and contains a higher percentage of mineral matter, while in deep areas the vegetable matter is more fibrous, and if a more detailed classification had been made would have been classed as Peat. Muck to a depth of 6 to 12 inches averages a jet-black mass of highly decomposed vegetable matter, mixed with a small percentage of mineral matter. Below this depth the black color gives way to a lighter brown, and the organic material changes from nonfibrous to more and more fibrous and finally to true Peat. The depth of this organic soil varies considerably, even within small areas. Where it is shallow, the underlying stratum consists of gray loam to silty clay loam, which in the lower depths has a greenish to bluish cast, very much like that of some marls. Some shallow areas have an extremely stony stratum beneath the organic soil. Areas occupying old lake beds are extremely variable in depth, which may range from a few feet in the shallower basins to deposits whose depths local soundings have failed to determine. Muck of this character is found bordering Salmon Brook Lake, as well as numerous smaller lakes. In some of the larger areas the material is also generally quite deep toward the center.

Where the Washburn loam and Muck in the virgin state are associated, it is often difficult to determine the boundary between them. In general the areas are classed with the Washburn loam rather than Muck where the organic matter is not more than 4 to 5 inches in depth on an average.

Muck is found principally in the stream valleys in all parts of the area, but the area is proportionately larger in the southern part. The bodies are irregular in shape and range in size from a few acres to more than a square mile. The largest bodies are found in New Limerick, Linneus, and Hodgdon Towns.

The Muck owes its origin to the accumulation and decay of vegetable matter. The process is still going on in many of the shallow lakes and depressions and is gradually reducing the water area of the lakes.

Artificial drainage must be supplied before this land can be brought under cultivation. Only a very small acreage is at present farmed, and the cleared area is used mostly for hay and pasture. The opinion is general that Muck produces scabby potatoes, but observations made in this region indicate that here this is not generally true, except where the organic soil is so shallow that it works up with the underlying material and really forms Washburn loam. It is generally observed that the yields are less and the tubers smaller on the Muck than on other soils, but they are usually free from scab, particularly if the field is new, in which cases the soil may have been free

from infection. The reaction of this soil wherever examined was sufficiently acid to inhibit the growth of the scab organism.

The native tree growth upon the Muck is for the most part cedar (arbor vitae), with some tamarack, spruce, and fir. The presence of tamarack is an unfailing indication that the soil is Muck. Openings occur which are devoid of tree growth. The organic covering of the type in a few places has been burned off in the past, and the forest growth destroyed. The forest is usually very dense, and in places almost impenetrable.

The Muck at the present time is of very little importance except for the forest it supports. As long as better drained soils are still available for cultivation it is not likely that it will come into use to any extent, except as pasture and hay land.

This land in its virgin state ranges in sale value from $2 to $20 or $25 an acre, according to the stand of pulp wood and other timber, and the nearness to market.

SUMMARY.

The Aroostook area is situated in the eastern part of Aroostook County, which forms the extreme northern part of Maine. The area surveyed includes practically all that portion of the county under cultivation. It comprises approximately 1,090 square miles, or 697,600 acres.

The most important towns of the area are Houlton, the county seat, Presque Isle, Caribou, Fort Fairfield, and Van Buren. Aroostook County in 1910 had a population of 74,664, the greater part of which is confined to the area surveyed. There are no large cities.[1] Outside markets are available through good railroad facilities.

The topography is undulating to hilly, with a few conspicuous low mountains. The surface is characterized by high, level to undulating ridges, with long sweeping slopes.

The area is drained by the St. John River on the north, the Aroostook River in the center, and the Meduxnekeag River in the southern part. These streams furnish water power which is used for operating mills and generating electricity for lighting and power.

The winters in this region, though long and cold, permit of work in the woods, and most of the lumbering is done at this season. The summers are mild and pleasant. A week or ten days of hot weather may occur, but high temperatures are never of long duration. The climate, on account of the moderate summer temperature, is particularly adapted to potatoes.

Potatoes and hay are the chief money crops. The beginning of the starch industry in 1874, and the opening of outside markets by the building of railroads about that time led to the development of the potato industry, about which all farming operations at the pre-

[1] See footnote, page 7.

sent time center. The production of seed potatoes has become most profitable, although a large percentage of the late varieties go for table use. The "Aroostook potato" is in demand in all parts of the country, particularly in the East, Middle West, and South. The scabby and inferior grades of potatoes are usually sold to the local starch factories. A factory located at Caribou manufactures potato flour and other potato specialties.

Potatoes, oats, wheat, and hay are grown on practically all the soils, but potato growing is largely centered upon the Caribou loam, which is an extensive soil and one highly adapted to the crop.

The system of rotation usually followed includes one or two years in potatoes, one year in grain, as a nurse crop for clover and timothy, and one or two years in hay.

The selling value of the average farm land ranges from $50 to $100 an acre. Near the towns some farms are valued at $150 to $200 an acre. Farm land is generally leased on a half-and-half share basis, but more than 95 per cent of the farms are operated by the owners.

Practically all of the soils of the area are derived either directly or indirectly from glacial materials. For the most part they are easy to cultivate and can be handled with the latest types of labor-saving machinery.

The Caribou loam is the most extensive and widely distributed type in the area. Its loose structure admits of easy cultivation, and its position upon the high, undulating ridges insures good drainage at all times. It is suited to all farm crops, but is particularly well adapted to potatoes.

The Caribou silt loam has the same crop adaptations as the loam, and similar cultural methods are followed. It occurs chiefly in the vicinity of Mars Hill and and Robinsons.

The surface soil of the Caribou gravelly loam is composed largely of coarse sand and gravel, both angular and rounded. The subsoil is usually a mass of water-laid gravel. The type consists of morainic and outwash materials.

The Caribou stony loam occupies the crests of high hills and mountains. It is generally nonagricultural and can best be kept in forest.

The Caribou fine sandy loam is found topping some of the higher morainic gravelly ridges. Although the surface and subsurface soil is comparatively free from gravel or coarse materials, the type is always underlain with water-laid gravel at varying depths. It is very limited in acreage and is of little importance agriculturally.

The Washburn loam is closely associated with the Caribou loam and often occurs in the same field. They receive the same treatment, but the results obtained are frequently quite in contrast. The type is well suited to grain and grasses, but potatoes are likely to be inferior in quality to those grown upon the better drained soils.

The Easton loam differs from the Washburn loam mainly in its lighter color. Both types occupy depressions or basins, which are usually surrounded by the Caribou loam or some other closely related soil. The type is well suited to pasture and hay grasses, but is not so well adapted to potatoes.

The Chapman loam is not a clearly defined type, but is rather a mixture of two or more soils that could not be mapped separately. It is usually made up of well-drained hummocks interspersed with poorly drained bodies. It is generally best suited to pasture or hay grasses.

The Linneus silt loam occurs in the southwestern portion of the area. It is the only dark soil in the area which is not poorly drained. It is apparently in part of glacial and in part of residual origin. The type is well adapted to all the crops grown, and gives large yields of potatoes.

The Keegan silt loam is confined to the terraces along the St. John River. It is naturally poorly drained and is best suited to pasture or hay grasses. It is not well adapted to potatoes.

The Van Buren silt loam also occurs upon the terraces of the St. John River, but in addition it is the predominating terrace soil along the Aroostook River.

The Van Buren sandy loam occurs only along the Aroostook River, and is of very small extent.

The Aroostook silt loam is the only first-bottom type mapped. It occurs chiefly along the Aroostook River, but is also found along the North Branch of the Meduxnekeag River and upon the islands of the St. John River.

Muck is found in all parts of the area, chiefly in the valleys and in former lake basins. It remains mostly in virgin forest, the principal growth being arbor vitæ cedar. The type is not well suited to potatoes, and reclamation is not considered profitable as long as better drained lands are readily available.

The area, on the whole is in a very prosperous condition. The homes are substantial, and many are lighted by electricity. Practically all are equipped with telephones. Rural mail delivery service is available to all the farms. Most of the farmers have automobiles, and trucks and tractors are coming into use. The latest improved machinery is used for preparing the land and planting and harvesting the crops. The surplus potato crop is handled in large storage houses built especially for the purpose. The draft stock used in farm operations is probably as fine as can be found in the country.

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[PUBLIC RESOLUTION—No. 9.]

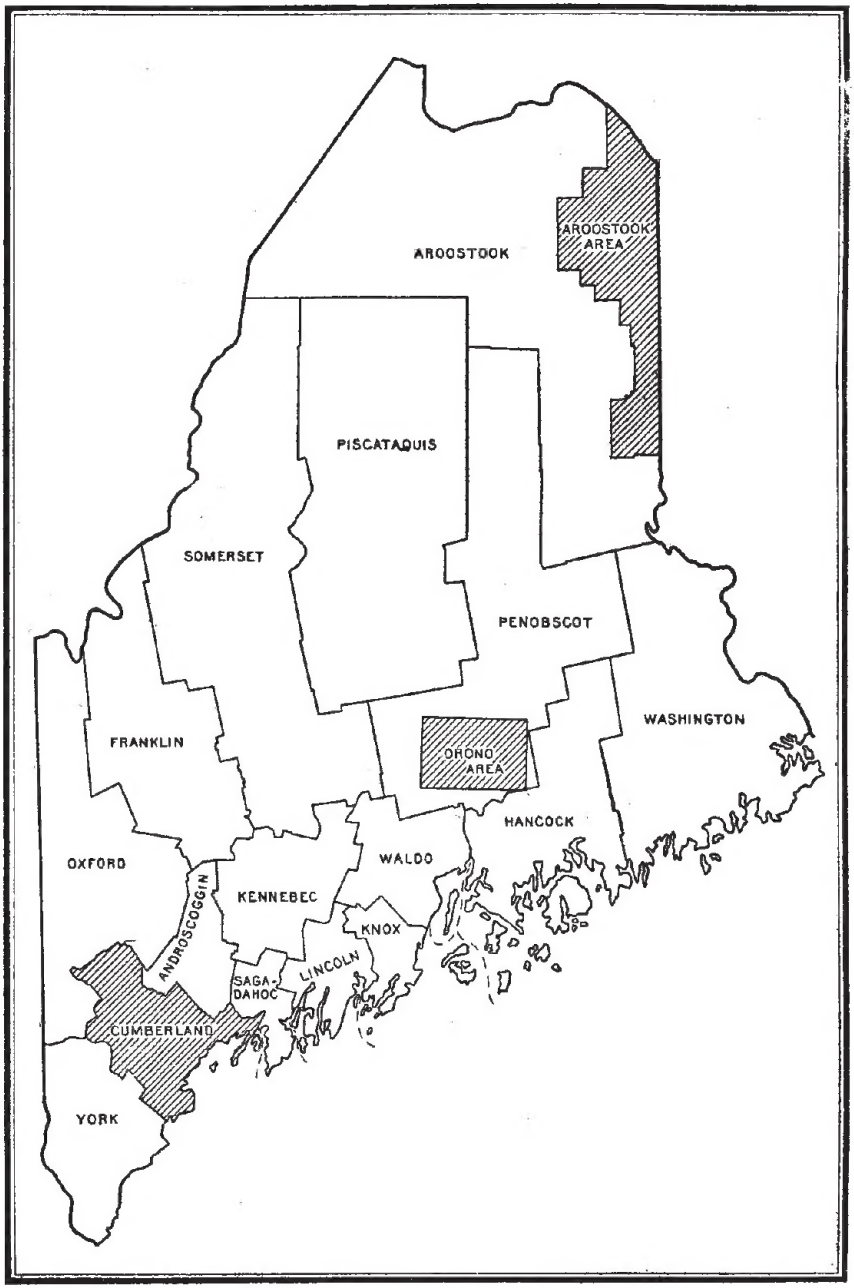
JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided*, That in addition to the number of copies above provided for there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved, March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils.]



Areas surveyed in Maine.

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U. S. DEPT. OF AGRICULTURE
BUREAU OF SOILS
MILTON WHITNEY, CHIEF
CURTIS F. MARBUT IN CHARGE SOIL SURVEY

SOIL MAP
MAINE
AROOSTOOK AREA, NORTHERN SHEET

BUREAU OF PLANT INDUSTRY
Wm. A. TAYLOR, CHIEF.
SOIL FERTILITY INVESTIGATIONS
OSWALD SCHREINER, IN CHARGE

W. E. McLendon, Inspector, Northern Division.
Soils surveyed by Lewis A. Hurst of the Bureau of Plant Industry, in charge, and E. W. Knobel and B. H. Hendrickson of the Bureau of Soils.

Scale 1 inch = 1 mile

PORTION OF SOIL SURVEY MAP OF
THE AROOSTOOK AREA, MAINE
PUBLISHED 1917

A. Hoen & Co. Lith. Baltimore, Md.

Field Operations
Bureau of Soils
1917

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BUREAU OF SOILS
MILTON WHITNEY, CHIEF
CURTIS F MARBUT, IN CHARGE SOIL SURVEY

SOIL MAP
MAINE
AROOSTOOK AREA, SOUTHERN SHEET

BUREAU OF PLANT INDUSTRY
Wm. A. TAYLOR, CHIEF
SOIL FERTILITY INVESTIGATIONS
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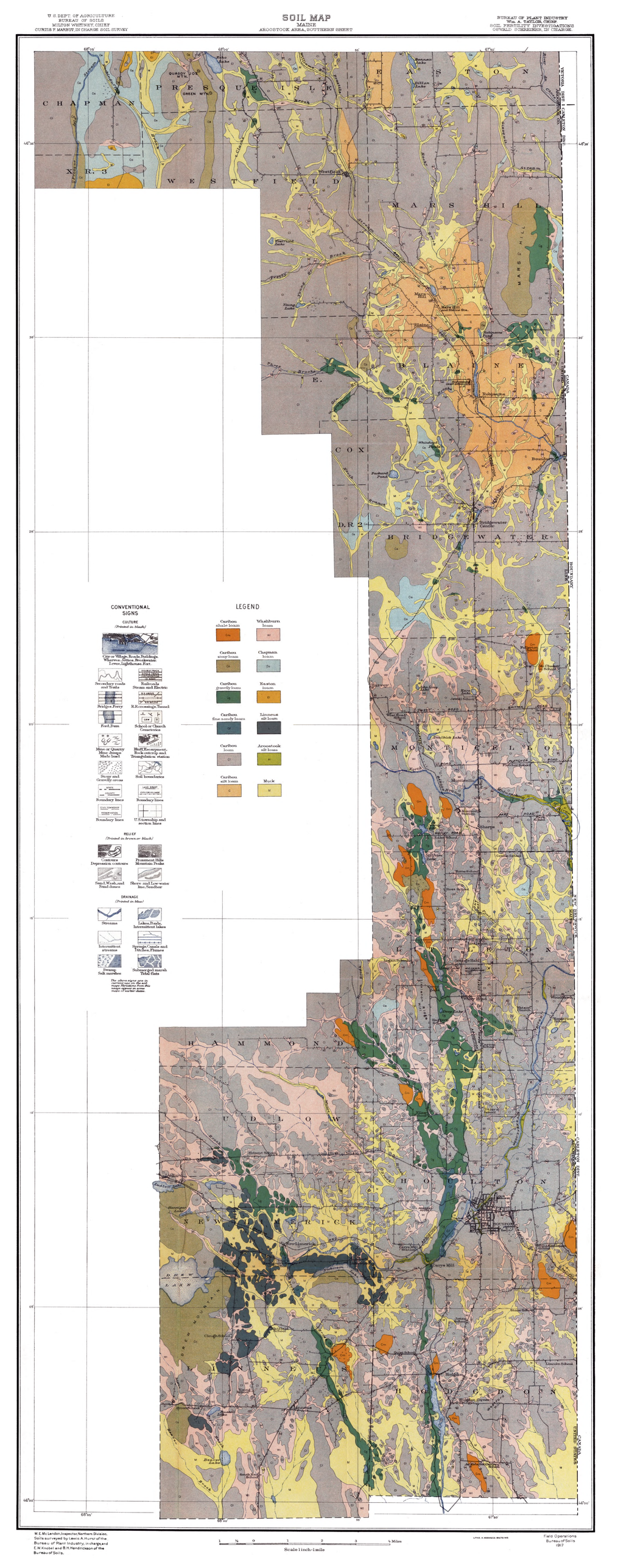

W. E. McLendon, Inspector, Northern Division. Soils surveyed by Lewis A. Hurst of the Bureau of Plant Industry, in charge, and C.W. Knobel and B.H. Hendrickson of the Bureau of Soils.

LITHO. A. HOFFMAN BALTO. MD.

Field Operations Bureau of Soils 1917